“STRATEGIC DESIGN OF A 2-STOREY CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATION AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE, BULACAN”

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Bachelor of Science in Civil Engineering

Major in Construction Engineering

and Management

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2025

RECOMMENDATION

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We hereby certify that this thesis is our own work and that to the best of our knowledge and belief, it contains no material previously written or published by another person or organization nor any material which has been accepted for award of any other degree or diploma from a university or institution of higher learning, except where due acknowledgement is made thereof.

Furthermore, we declare that the intellectual content of this thesis is the product of our work, although we have received assistance from others on the manner of organization, presentation, language, and style.

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CHAPTER 1

The Problem and its Background

This chapter presents the study overview, including the introduction, background of the study, theoretical framework, statement of the problem, hypotheses, scope and limitations of the study, significance of the study, and definition of terms.

Introduction

The City of San Jose del Monte, Bulacan (CSJDM) has undergone remarkable transformation from a resettlement area to a developing, economically independent community, earning recognition as "The Rising City." Its rapid development is driven by its strategic location near Metro Manila, providing excellent connectivity and attracting homebuyers and businesses. This growth has stimulated expansion in real estate, commercial, and social services sectors, supported by new infrastructure, economic investment, and a growing, diverse population. Consequently, the urban landscape has shifted, with increasing residential and commercial developments transforming land use and shaping the city’s modernization trajectory.

The city's rapid growth has also elevated the risks associated with fire incidents and other emergencies, especially in densely populated residential and commercial areas. Many existing fire stations are outdated, and emergency facilities are limited, highlighting the need for improved and modernized infrastructure. The Bureau of Fire Protection (BFP) reports that most fire incidents in the Philippines are caused by faulty electrical wiring, overloaded outlets, and open flames or LPG leaks (Philstar, 2025). Despite local programs to improve fire response in schools and barangays, challenges such as slow response times, inadequate station facilities, and lack of strategic planning persist (CSJDM LGU, 2024).

The Fire Code of the Philippines sets standards for fire safety and fire station construction, but CSJDM's rapid development has outpaced its emergency facilities. Studies indicate that sub-optimal fire station locations increase response times and property damage (Labita & Namoco, 2023). The city faces exposure to both natural disasters, such as typhoons and earthquakes, and man-made emergencies, including medical incidents, search and rescue, and hazardous material events. Current infrastructure and coordination limitations hinder effective disaster response, putting lives, property, and community resilience at risk.

Establishing a centralized fire station in CSJDM is vital to address these challenges. A centralized facility would enable coordinated deployment of personnel, vehicles, and rescue equipment, reducing emergency response delays. Incorporating training facilities, medical response units, and modern communication systems

would strengthen operational efficiency for both man-made and natural disasters. Global frameworks, such as the UNDRR Strategic Framework 2022–2025, emphasize centralized coordination, resource management, and preparedness to reduce disaster risks (UNDRR, 2022). Strategic placement of fire stations using P-median and maximal covering models has been shown to improve service coverage and response times in other Philippine cities (Habibi et al., 2023). This study aims to design a centralized fire station for CSJDM that integrates modern facilities, effective coordination mechanisms, and data-driven planning to enhance community resilience, save lives, and ensure timely emergency response for the city's growing population.

Background of the Study

Rapid urban growth, rising populations, and increased business activity in every municipality in the Philippines are leading to more frequent and complex responses to fires, road accidents, and other emergencies that require immediate and effective action. The City of San Jose del Monte is experiencing changes in land use, higher traffic, and a lack of emergency facilities. Some existing facilities are not well-maintained. This situation shows a clear need for better solutions for local emergency operations and responses.

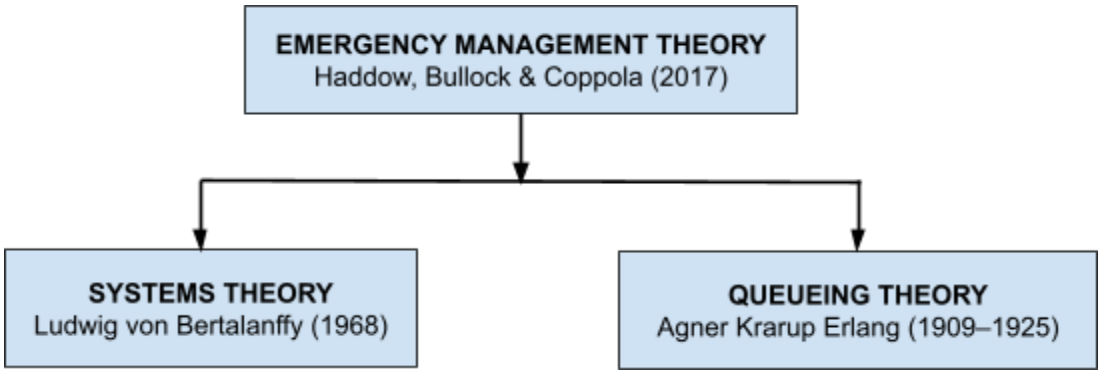
Fire incidents are one of the significant threats to lives, properties, and overall safety of communities. The efficiency of firefighting operations and emergency responses also depends on equipment, the availability of adequate

facilities, and a well-coordinated fire station system. However, nowadays there are many outdated facilities and long response times, which compromise public safety and disaster management. To tackle this issue, the researcher will create a design of a centralized fire station. This station will allow for an effective distribution of manpower, vehicles, and rescue equipment in one strategic location. It will enable quick deployment during emergencies.

The design also encourages better coordination among firefighting teams and improves disaster preparedness measures. By centralizing operations, the fire department can make the most of its resources and reduce delays, which are crucial in life-threatening situations. The primary objective of locating a fire station is to minimize response time, the interval between receiving a call and arriving at the incident site." (Kobos & Ross, 2025)

Additionally, the design of a centralized fire station is not just about constructing a structure, but the design also talks about integrating functionality, efficiency, and community safety. Modern fire stations are composed of rescue equipment storage, must be equipped with training facilities, must have emergency medical response units, communication technologies, and barracks. The study of designing of facilities emphasize the significance of establishing a hub that meets firefighting, rescue, and emergency demands. Therefore, providing a sustainable and long-term solution for safeguarding the community is essential.

Theoretical Framework



According to Ludwig von Bertalanffy (1968), Systems Theory emphasizes the need to integrate facilities and coordinate personnel, equipment, and the community as connected parts. This approach suggests that effective fire station design should view these elements as a unified system working together for greater efficiency. When personnel, facilities, equipment, and the community work together systematically, the fire station is better prepared to handle fire emergencies effectively. Haddow, Bullock, and Coppola (2017) discussed in Emergency Management Theory, particularly the Comprehensive Emergency Management (CEM) framework, that preparedness, response, and recovery are key elements in disaster management. Preparedness involves well-planned barracks, simulation facilities, and the right equipment. Response requires vehicle bays, and strategies for quick deployment. Recovery focuses on medical and rescue facilities and the support needed after disasters. These phases work together to ensure the fire station can reduce risks, respond quickly to emergencies, and provide necessary assistance during operations. Additionally, Agner Krarup Erlang (1909-1925) introduced Queueing Theory. This theory highlights the importance of response time and efficient resource use. Applying it to fire station operations shows the need for better dispatch systems, shorter waiting times, and faster emergency responses.These theories form the foundation for the centralized fire station design in the City of San Jose del Monte, Bulacan, aiming to enhance community safety, improve response efficiency, and strengthen disaster resilience.

Figure 1: *The theoretical framework illustrates theories from different studies.*

IPO Conceptual Framework

INPUT	PROCESS	OUTPUT
1.Respondents' Demographic Profile, in terms of: 1.1 Gender 1.2 Current Field of involvement (BFP personnel, rescuers, OJTs) 1.3 Current Place of assignment 1.3 Type of emergencies frequently responded to	**1. Data Collection** ● Distribution of survey questionnaires to BFP personnel, OJTs, rescuers, and related respondents. ● Key informant interviews with Fire Marshals, Station Commanders, and emergency operations officers. ● Observation and site visits to existing fire stations for validation of spatial and facility conditions.	
2.How should a centralized fire station be designed to meet requirements based on user preferences and survey data in terms of: 2.1 Drone operation and monitoring area 2.2 Modern vehicle bays for fire trucks and rescue units.	**2. Data Analysis** ● Analysis of survey responses using frequency, percentage, and weighted mean to determine the importance of facilities. ● Thematic analysis of interview responses	

2.3 Command and control center with advanced communication systems 2.4 Training and simulation facilities 2.5 Medical and rescue support room 2.6 Barracks and living quarters for firefighters and rescuers 2.7 Additional support facilities based on preferences and gathered data from survey	to identify operational challenges and space requirements. ● Comparison of findings with building and fire protection standards. ●	
3. How do reference standards and guidelines influence the design and operation of fire stations in terms of: 3.1 National Building Code of the Philippines (NBCP) 3.2 National Fire Code (RA 9514) 3.3 Bureau of Fire Protection Modernization Act (RA 11589) 3.4 International design standards for fire stations and emergency facilities	**3. Design Development** ● Formulation of a space program based on identified facility needs and personnel requirements. ● Preparation of a site development plan, floor plan, architectural layout, and structural concept. ● Integration of modern firefighting technologies and accessibility features.	

Table 1: *The conceptual framework represents the transformation of data into output*

Statement of the Problem

The City of San Jose del Monte, Bulacan rapid growth has increased fire risks, yet its fire station facilities remain inadequate due to accessibility issues, uneven staffing, and outdated infrastructure. With BFP personnel stationed in a facility that is poorly arranged for operational needs, the city's emergency response capacity is limited. This study proposes establishing a modern Centralized Fire Station to enhance operational efficiency, improve public safety, and strengthen the city's resilience to fire emergencies.

Specifically, this study aims to answer the following questions:

1. What is the demographic profile of the respondents in terms of:

    2.1 Gender

    2.2 Field of Involvement

    2.3 Present Place of Assignment

    2.4 Type of Emergencies Most Frequently Responded To

2. What are the present status and challenges faced by the fire stations currently operating in the City of San Jose del Monte, Bulacan in terms of:

    2.1 Facility Adequacy and Personnel Accommodation

    2.2 Operational Layout and Deployment Efficiency

2.3 Accessibility and Community Engagement

2.4 Infrastructure Capacity and Sustainability

3. How do the needs and preferences of the Bureau of Fire Protection (BFP) San Jose del Monte influence the design of a centralized fire station in terms of:

3.1 Firefighting Facilities (e.g., vehicle bays, equipment storage)

3.2 Rescue and Medical Facilities (e.g., recovery units, medical stations)

3.3 Emergency Support Facilities (e.g., barracks, command center)

4. How spatial layout and design considerations can be developed based on the operational and functional needs identified through surveys and interviews in terms of:

4.1 Space allocation and distribution

4.2 Facility zoning and functional relationships

4.3 Space allocation for vehicles, personnel, and equipment

4.4 Circulation flow and accessibility within the facility

Objectives of the study

The main goal of this study is to design and assess a centralized fire station at Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan. It will focus on modern facilities that can improve firefighting, rescue, and emergency response operations. This project aims to strengthen the Bureau of Fire Protection's (BFP) ability to operate, increase public safety, and address the city's growing needs from rapid urban growth.

Specifically, the objectives of the study are the following:

1. To determine the demographic profile of the respondents which are essential for designing facilities that effectively support operational functions and personnel well-being in terms of;

    1.1 Gender

    1.2 Field of Involvement

    1.3 Place of Assignment or Training

    1.4 Types of Emergencies Most Frequently Responded To

2. To assess the current status and challenges of fire stations in San Jose del Monte, Bulacan, to identify gaps in facility terms of:

    2.1 Facility Adequacy and Personnel Accommodation

2.2 Operational Layout and Deployment Efficiency

2.3 Accessibility and Community Engagement

2.4 Infrastructure Capacity and Sustainability

3. To evaluate and determine the needs and preferences of the BFP in San Jose del Monte regarding the design of a centralized fire station, in terms of:

3.1 Firefighting Facilities (e.g., vehicle bays, equipment storage)

3.2 Rescue and Medical Facilities (e.g., recovery units, medical stations)

3.3 Emergency Support Facilities (e.g., barracks, command center)

4. To identify the spatial and structural design considerations based on the operational and functional needs gathered from surveys and interviews in terms of:

4.1 Space allocation and distribution

4.2 Facility zoning and functional relationships

4.3 Space allocation for vehicles, personnel, and equipment

4.4 Circulation flow and accessibility within the facility

Hypothesis

Ha: There is a significant relationship between the inclusion of modern and properly planned facilities in a centralized fire station and the improvement of firefighting efficiency, rescue operations, and emergency response in the City of San Jose del Monte, Bulacan.

Ho: There is no significant relationship between the inclusion of modern and properly planned facilities in a centralized fire station and the improvement of firefighting efficiency, rescue operations, and emergency response in the City of San Jose del Monte, Bulacan.

Significance Of the Study

This study may contribute to the safety and resilience of the City of San Jose del Monte by emphasizing the benefits of establishing a centralized fire station equipped with modern facilities. The proposed development aims to strengthen emergency response, improve operational efficiency, and enhance public protection across various sectors of the community.

For the **community**, this study offers direct support to the residents of San Jose del Monte by promoting faster emergency response and improved public safety. With features such as recovery units and barracks, a centralized fire station can help protect lives, property, and livelihoods from fires and disasters.

For the **Department of the Interior and Local Government (DILG)**, this study aids in addressing long-standing issues such as outdated infrastructure, limited accessibility, and insufficient rest areas for personnel. The provision of modern amenities enhances the department's capacity for firefighting, rescue operations, and disaster response.

For the **local government**, the findings of this study serve as a guide for strengthening urban planning and disaster preparedness in the city. It provides a foundation for investing in safety infrastructure that meets the needs of a rapidly growing urban population.

For the **urban development and construction sector**, this research introduces updated approaches to fire station design. By highlighting modern features such as command centers and medical stations, it serves as a reference for creating resilient and safety-focused infrastructure projects in the future.

For the **academic field**, this study contributes to the understanding of how civil engineering, architecture, and disaster management intersect. It offers valuable material for students, educators, and researchers in designing community safety facilities.

For **future researchers**, this study establishes a foundation for further investigation into centralized fire station designs. It encourages exploration of traditional layouts, emerging technologies in public safety infrastructure, and

sustainable building practices that can strengthen resilience and operational efficiency.

Scope and Limitation

This study, conducted by researchers from La Concepcion College Inc., focuses on the design of a centralized fire station in the City of San Jose del Monte, Bulacan, specifically at the Motorpool, Barangay Sapang Palay Proper, during the academic year 2025–2026. It covers the development of a site plan, floor plans, 3D architectural layouts, elevations, structural designs, project schedules, and Bill of Quantities (BOQ), designing using AutoCAD and SketchUp, emphasizing essential facilities suggested by BFP respondents to enhance emergency response, rescue operations, and firefighting efficiency.

The research is limited to conceptual and design stages, with data collected from the key fire and emergency response facilities within the City of San Jose del Monte, Bulacan, including the BFP Main Office – CDRRMO Building in Barangay Sapang Palay Proper, Poblacion 1 Fire Station in Daang Barangay, Tungkong Mangga Emergency Response Facility, and Muzon Emergency Response Facility. Structural investigations, physical modeling, interior design, construction, acquisition of materials, financial planning, operational management, and long-term maintenance are excluded. Only emergency situations related to fire incidents, rescue missions, and local natural calamities like typhoons and earthquakes are considered, while

incidents such as terrorism, pandemics, or other extraordinary events are outside the scope.

Definition Of Terms

BFP (Bureau of Fire Protection) – The national agency mandated to prevent and suppress fires, enforce fire safety laws, and respond to emergencies.

Barracks – Sleeping and resting quarters provided for firefighters who stay on duty within the fire station.

Centralized – A system in which operations, resources, or facilities are placed in a single, main location for improved coordination and efficiency.

Community Resilience – The ability of a community to withstand, adapt to, and recover from disasters or emergencies.

Data-Driven – An approach that uses analysis, statistics, and information to guide decisions and improve performance.

Disaster – A serious disruption caused by hazards, resulting in widespread damage to life, property, and community functions.

Efficient – The ability to achieve maximum productivity with minimum wasted effort, time, or resources, especially in emergency response and facility operations.

Emergency – An unexpected situation requiring immediate action, such as fires, accidents, or natural disasters.

Emergency Operations – Coordinated actions carried out during emergency

situations to manage and control incidents effectively.

Fire Incidents – Occurrences of fire that require immediate response and intervention by firefighters to prevent damage to life, property, and the environment.

Fire Marshal – A BFP official responsible for overseeing fire safety enforcement, inspections, investigations, and the overall operation of a fire station.

Fire Safety – Practices and measures that reduce fire risks, prevent ignition, and ensure safe evacuation and response in emergencies.

Fire Station – A facility that houses firefighters, vehicles, equipment, and resources for responding to fire-related and emergency situations.

Hazard – A potential source of harm, damage, or adverse effects such as fires, earthquakes, or chemical spills.

Infrastructure – The physical structures and facilities needed for effective fire station operations, including utilities, buildings, and access roads.

Living Quarters – Spaces within the fire station designated for resting, eating, and daily activities of personnel during their shifts.

Man-Made Disaster – A harmful event resulting from human actions, such as fires, industrial accidents, or structural failures.

Medical Response Units – Specialized spaces or teams within a fire station equipped to provide first aid and pre-hospital care.

National Fire Code – A set of regulations guiding fire safety requirements, prevention measures, and compliance standards nationwide.

National Structural Code of the Philippines (NSCP) – The engineering code outlining standards for structural design to ensure safety, stability, and resilience of buildings.

NBCP (National Building Code of the Philippines) – The legal framework regulating building construction, safety, and design standards in the Philippines.

Natural Disaster – A destructive event caused by natural processes such as earthquakes, floods, or typhoons.

Optimal Mitigation – The most effective strategies or measures implemented to reduce or minimize the impact of hazards.

Outdated Facility – A structure or station that no longer meets current safety, operational, or design standards and requires modernization or replacement.

Preparedness – Actions and plans implemented to ensure readiness before emergencies occur.

Queuing – A theory or process analyzing waiting times, service flow, and the efficient movement of emergency vehicles and personnel.

Response – The actions taken by firefighters and emergency personnel during incidents to save lives, protect property, and control hazards.

Response Time – The duration between receiving an emergency call and arriving at the incident site.

Risk – The likelihood of harm or loss occurring due to exposure to hazards.

Site Visit – An on-ground inspection conducted to assess the condition, layout, and

needs of a proposed or existing fire station.

Space Program – A structured layout plan identifying the required spaces, areas, and facilities needed in the design of a fire station.

Strategic – Refers to actions or plans designed to achieve long-term goals, particularly in improving emergency response, infrastructure planning, and public safety.

Training Facilities – Designated areas within a fire station used for skill development, drills, and capacity building of personnel.

Vehicle Bays – Designated areas in a fire station where fire trucks and emergency vehicles are stored and maintained.

Zoning – Land-use regulations that determine where certain facilities, such as fire stations, may be built based on area classification and safety needs.

CHAPTER 2

Review of Related Literature and Studies

A review of relevant studies and literature is presented in this chapter, following a comprehensive search by both domestic and international researchers. They facilitate familiarization with pertinent and comparable information to the current investigation.

Foreign Literature

According to Shahparvari et al. (2020), the fire emergency quick response is essential because any delay can result in serious injuries, loss of lives, or even death. As the cities grow and urban areas become more complex, it is challenging to respond quickly. The researchers focus on Melbourne, Australia, analyzing the current distribution of fire stations using advanced location-allocation models with Geographic Information System (GIS). The study found that some neighborhoods experience longer response times exposing coverage gaps for fire services. By suggesting optimal new locations and recommending adjustments to existing stations, the study aims to improve coverage from 81% to 95% within a critical five-minute response window. This study will not only deal with faster firefighting

efforts but also with better protection for residents and to their properties. The study highlights the power of using spatial data and modeling tools to guide smart decision-making in emergency planning. In general, it highlights the importance of strategic fire station placement to save lives and enhance urban safety.

Fire safety in rapidly urbanizing cities like those in China is becoming a critical concern, with traditional fire station planning methods proving increasingly inadequate. According to Chen et al. (2025), in all efforts for improving emergency response infrastructure, high-density development and uneven resource distribution have created large service gaps, putting human lives and property at risk. The study highlights that the existing fire station siting standards, such as a 5-minute response radius and fixed service areas, often ignore the varying degrees of fire risk found across different urban zones, such as Industrial, commercial, residential, and institutional areas. It is intended that the location of the fire station is a big factor when it comes to response in a standard time.

According to Renkas et al. (2022), optimization of fire station locations to increase the efficiency of firefighting in natural ecosystems. This highlights the importance of locating the fire station specifically in natural ecosystems. Optimizing fire stations can ensure the protection of human lives and prevent the spread of fire in natural ecosystems and rural areas. Lack of fire stations and poorly located fire stations can be a threat to life and property. This is one of the reasons why fire stations should be increased or centralized to meet the standard

emergency response time.

According to Dey et al. (2021), it shows the delicate balance between the consolidating fire stations for efficient emergency response across the complex urban landscape. It emphasizes the matter of how the fire stations are placed relative to population density, road networks, traffic flow, and emergency demand because simply centralizing services won't automatically improve outcomes. The models show that a thoughtful consolidation, where some smaller fire stations are merged and a few robust central hubs are strategically located, can reduce duplicative coverage and demand patterns. The article says it's about the better-location, better-connected ones, and not because of fewer stations.

According to KC et al. (2024), fire protection in Kathmandu is not merely a planning issue but a vital public safety concern. The study observes that some areas take more than ten minutes for responses because population and infrastructure are increasing rapidly. From 2019 to 2023, using ward-level, only 30 percent of buildings in Kathmandu are reachable. Their suitability analysis combines variables like fire rate, return time, street connectivity, and population to score wards for potential new station placement, then refines possible sites through overlaying land use and river proximity. This study found that peripheral wards in particularly 31 and 32, are prime candidates for new stations to reduce underserved zones. More than numbers, the authors connect fire risk to social vulnerability. Areas with many renters, low schooling, and LPG usage show stronger fire patterns, urging equitable planning. Their work urges that locating

fire stations is more than geometry and it's about reducing human vulnerability in dense, fast-changing cities. Finally, it hopes their framework can guide policy in similar developing cities, where sparse data and high stakes make smart design essential.

Local Literature

According to the Bureau of Fire Protection (2022), fire station placement plays a critical role in minimizing dispatch delays and reducing both loss of life and property damage (as noted by Abalos 2022). This highlights that response time is the most important factor in emergency services like fire stations. The longer it takes for a fire response team to arrive, the higher the risk of fatalities and property damage. Therefore, fire station sites and routes must be chosen carefully to ensure fast and efficient operations.

The Commission on Audit (2024) found that as of end-2023, 146 municipalities still lacked active fire stations or adequate fire trucks, highlighting that many fire-protection hubs remain sub-optimally located and under-resourced for effective emergency response. This gap persisted in subsequent years, with unmet performance targets reflected in the BFP's quarterly operational reports from 2018 to 2023 (Department of the Interior and Local Government – Bureau of Fire Protection, 2018–2023).

The passage of the BFP Modernization Act (Republic Act 11589, 2021) further reinforced the importance of upgrading fire stations nationwide. This law

mandates capital enhancements for BFP facilities, equipment, and personnel, intending to reduce response times and ensure operational efficiency across all Local Government Units (LGUs). By 2025, about 1,484 LGUs had BFP stations, though several remained pending for full operational status. In Davao Region, for instance, the BFP has set a seven-minute response time benchmark, with barangay-level substations being planned to avoid service gaps. However, infrastructure limitations remain a challenge, as seen in Dumaguete City, where the fire chief (2024) stressed the need for more fire hydrants in high-risk areas to complement station response.

Recent studies have focused on improving fire station placement using facility location modeling. Subteniente and Gomez (2024) applied models such as the Set Covering Location Problem (SCLP) and Maximal Coverage to recommend expansion sites for fire station infrastructure in Metro Manila, based on demand and incidence data. From a technical perspective, optimization methods like the Maximum Coverage Location Problem (MCLP) are useful for identifying ideal station locations. Atta et al. (2021) and Hamed et al. (2023) demonstrated applications of MCLP in urban emergency services, highlighting its potential to guide Philippine station placement. These models provide structured ways to evaluate high-risk versus low-risk locations, ensuring resource allocation is aligned with disaster preparedness and efficient coverage.

In local practice, GIS-based facility location modeling has been used to assess underserved areas and optimize station siting in highly urbanized areas.

Cruz, Ong, and Peralta (2022) applied a GIS-based multi-criteria analysis in Quezon City to map service areas of existing fire stations, revealing that poor coverage and road network limitations extended response times. Their study integrated the Analytic Hierarchy Process (AHP) with GIS to evaluate population density, hazardous land uses, road proximity, and distance to stations, exposing service gaps caused by network and siting limitations. Applying these GIS-based approaches to San Jose del Monte would provide an evidence-based strategy for siting a centralized fire station that meets the five-to-seven-minute response standard.

Improved incident reporting, mapping, and dispatch can also cut down delays in identifying and routing to fire sites, according to local technology initiatives. The creation of the Tabang fire emergency response application (Central Philippine University, 2022) serves as an example of how dispatch procedures may incorporate real-time situational data and GPS-enabled citizen reporting to facilitate quicker response. Designing a centralized station with a functional communications/ICT hub improves situational awareness for workers and controllers and allows for compatibility with such applications (Gubat, Lam, & Rabanes, 2022).

Foreign Studies

According to Moore (2023) in assessing fire station response and coverage ability in a Pennsylvania Town, there was a gap in fire station response times in a Pennsylvania township. Stations are staffed by volunteers, which creates problems with coverage and timely responses. As stated by Anderson (2021), it confronts the growing disconnect between the evolving needs of communities and the aging infrastructure and outdated models used in the fire volunteer services. As volunteerism continues to decline across the U.S., the one studied by many fire departments struggles with the old facilities, insufficient staffing, and resistance to change. The study sheds light on how some fire personnel cling to tradition or rely on ineffective planning methods, even when response times fall short of the NFPA's (National Fire Protection Association) “nine-minute, 90% of the time” standard. Anderson notes that while some firefighters are reluctant to consider relocation or a new station, the data shows that existing stations are poorly placed, leaving gaps in coverage and slowing response times. The research identifies critical spatial and operational gaps in the current system through a need-based assessment. The study argues that the fire service must evolve when it comes to realigning its resources with the realities of modern growth and risk. The Study highlights the value of data-driven analysis in justifying the siting of new fire stations and improving emergency coverage. Overall, fire departments can support not only public safety but also long-term community development and economic stability. Anderson’s work

humanizes fire service planning by framing it as a vital part of improving residents' quality of life.

As stated by Han et al. (2021), this study addresses the growing challenges faced by some urban areas, as rapid city expansion and increasing fire incidents put lives, property, and overall safety at risk. The study points out how critical the spatial arrangement of fire stations is to effective firefighting but points out that previous research often overlooks key issues like the randomness of fire outbreaks and traffic delays, which significantly affect response times. Using an innovative approach, the authors combine a set cover location model with spatiotemporal big data to link actual fire outbreak points with real-time traffic conditions, ensuring emergency teams can reach incidents quickly. It focuses on Nanjing, China, and it analyzes extensive data from fire incidents between 2014 and 2018, traffic congestion data, and existing firefighting infrastructure to understand fire risk patterns and calculate risk scores. The study applied clustering and Monte Carlo simulations to generate realistic random fire scenarios. The study sets a five-minute time response and vehicle speeds on each road to calculate travel times across the area. The final results were fine-tuned according to city land use plans, which led to a dramatic improvement in fire service coverage, increasing it from 58% to 90%. By combining big data analytics with traffic dynamics, the approach goes beyond traditional models, creating a more precise and adaptable framework for emergency planning. In general, the study deals a valuable insight for urban planners to look for the enhancing of fire safety through data-driven, responsive infrastructure design. By

doing so, it contributes to improving public safety and resilience in fast-growing cities worldwide.

According to KhoshAmooz (2024), as the population grows, fire stations are in demand as essential emergency services, making the strategic placement of fire stations more critical than ever. The study, which focused on Tehran, addresses the pressing issue of limited service coverage and delays in emergency response due to inefficient fire station distribution. The distance from existing stations, proximity to main roads, high population density areas, gas and fuel stations, historical and cultural sites, green spaces, and evacuation zones are the key criteria of evaluating the new location of fire stations. Additionally, the 5-minute service range of existing fire stations was calculated and excluded from consideration to avoid overlap and redundancy. As a result, five underserved districts—Regions 14, 15, 16, 17, and 20—were identified as high-priority areas for future fire station development. The study not only points out the importance of multi-criteria decision-making in urban planning but also gives a replicable data-driven model for other cities experiencing the same scenario. It reflects the global recognition that fire safety must evolve with urban growth. The study aims to enhance public safety through smarter, more inclusive planning decisions.

In “A Composite Approach for Site Optimization of Fire Stations,” Badi et al. (2022) tackled that the biggest challenge is the dispersed location of fire stations, which slows down reaction time because it takes an hour for rescue personnel to reach the scene. This study highlights the model for determining the ideal location of

a fire station in Misurata. To solve this, the blend FUCOM-COCOSO approach, allowing both quantitative data and expert insight to steer the decision. They evaluate sites based on six criteria. The population density, distance to existing stations, proximity to industrial zones, closeness to main roads, residential and commercial densities, and discover that densely populated zones carry the greatest weight. Their results suggest the ideal fire station should be near industrial clusters yet within reach of heavy residential zones, reflecting the way emergencies don't wait for neatly drawn boundaries. Although they haven't integrated GIS path analysis, their method offers a practical, human-centered way for planners to think about fire station consolidation or expansion in rapidly changing urban landscapes.

According to He et al. (2024), urban fire station locations should evolve beyond the traditional "build in every built-up area" approach to one rooted in risk, demand, and geography. They present a case study of Shanghai in which they assess fire risk across over nineteen thousand spatial units, using indicators like population density, incident density, building volume, land-use type, GDP density, and spatial location to classify areas into four risk levels (A-extremely high, B-high, C-moderate, D-low). Leveraging tools such as the Baidu Map API for realistic travel times over road networks and Gurobi for solving optimization, they explore different fire station deployment scenarios (50, 100, 150, etc. stations). Their findings suggest that constructing around 150 well-located stations offers a balance where the marginal gains in response coverage taper off beyond that number, yet still significantly improve response times and cover areas more uniformly. Importantly,

this approach identifies inefficiencies in the existing distribution of Shanghai's 152 stations; many densely built-up areas have overlapping low-demand jurisdictions, while suburban areas suffer large, thinly-served zones. By introducing risk-based models and hierarchical response time standards depending on area classification, this study humanizes station planning: it's not just about distance but about where people live, how built the environment is, how often fires happen, and what realistic travel paths look like. For other rapidly expanding cities, this work shows how data-driven, nuanced centralization and deployment can lead to more equitable, faster emergency response, while avoiding over-serving some areas and under-serving others.

Local Studies

Republic Act 11589, also referred to as the Bureau of Fire Protection Modernization Act of 2021, has placed a strong emphasis on modernizing fire stations in the Philippines. It requires that facilities, equipment, and personnel be upgraded nationwide in order to improve operational efficiency and decrease response times (Republic Act No. 11589, 2021). Despite this, many local fire stations continue to face logistical and infrastructure issues that limit their ability to consistently meet the required five- to seven-minute response time, according to the Bureau of Fire Protection's CY-2023 Annual Narrative Accomplishment Report (Bureau of Fire Protection, 2024).

Scientific approaches to alleviate these inefficiencies have previously been

investigated in highly populated places. In Quezon City, for instance, Cruz, Ong, and Peralta (2022) mapped fire station service areas using a GIS-based Analytic Hierarchy Process (AHP) and discovered that inadequate siting and road network constraints led to delayed responses. The Set Covering and Maximal Coverage placement Problems are two examples of facility placement models that Subteniente and Gomez (2024) used to suggest the best locations for fire station expansions in Metro Manila. These studies show how mathematical and geographical optimization approaches may be applied to ensure that urban people have fair access to services.

The Dumaguete City Fire Department also emphasized the importance of coordinated planning between the fire station's location and its supporting infrastructure, along with addressing siting and coverage issues (Philippine News Agency, 2024). Additionally, the creation of local technological solutions, like the Tabang fire emergency response application in Iloilo, demonstrates how ICT may facilitate quicker reporting and dispatching by allowing public engagement using GPS (Gubat, Lam, & Rabanes, 2022).

For fire stations to be efficient and functional, structural planning is just as important as location and ICT integration. Standard amenities for city-level fire stations must contain apparatus bays with sufficient clearance, a communications room, dormitories, administrative offices, training areas, and rescue equipment storage, under the Bureau of Fire Protection's Planning and Design Guidelines (2023). In addition to using durable building materials that can endure natural

calamities and fire dangers, the structural arrangement must guarantee the prompt deployment of fire vehicles from apparatus bays to the main road. Additionally, fire stations are guaranteed to serve as both emergency hubs and secure working environments through the incorporation of support infrastructure, including water supply tanks, standby generators, and appropriate zoning between residential and operating areas (Bureau of Fire Protection, 2023). Together, these local studies and reports show that the proposed centralized fire station in San Jose del Monte needs to be planned with integrated ICT facilities, supporting water infrastructure, and modernization standards in addition to strategic siting and road access. Its structural plan should also include full facilities that comply with BFP guidelines, including training areas, dormitories, communications and control rooms, and apparatus bays, so that the station can fully support emergency response, firefighting, and rescue operations.

Synthesis of the Related Literature and Studies

The studies and research papers reviewed highlight that response time is the most critical measure of efficiency in firefighting and emergency response. Altogether, they underscore the importance of strategic fire station siting, infrastructure modernization, and ICT integration, while pointing out persistent challenges in the Philippines such as poor coverage, inadequate support facilities, and infrastructural limitations. These works collectively stress that efficient fire station design is not only a matter of physical location but also of systematic

planning, modern facilities, and technology adoption to meet the national benchmark of a five- to seven-minute response time.

Republic Act 9514, or the Philippine Comprehensive Fire Code, establishes that firefighters must respond within five to seven minutes. This mandate is supported by Republic Act 11589 (2021), the Bureau of Fire Protection Modernization Act, which emphasizes upgrading fire stations, equipment, and facilities to reduce delays (RA 9514, 2008; RA 11589, 2021). Audit and performance reports from 2023 show that numerous fire stations under the Bureau of Fire Protection (BFP) remain poorly located or inadequately resourced, undermining response efficiency and fulfillment of coverage targets." (BFP-1st Sem 2023 Narrative Accomplishment Report, 2024)

Subteniente and Gomez (2024) used Set Covering and Maximal Coverage models to identify optimal station expansion sites in Metro Manila, demonstrating the value of mathematical approaches in improving service coverage. Similarly, Cruz, Ong, and Peralta (2022) applied a GIS-based Analytic Hierarchy Process (AHP) in Quezon City, revealing that inadequate siting and road network issues directly extended response times. These findings suggest that San Jose del Monte, with its mix of dense urban zones and peripheral barangays, would benefit from similar evidence-based modeling to ensure equal coverage.

Local accounts further emphasize support infrastructure gaps, such as Dumaguete City's (2024) reported shortage of fire hydrants in high-risk areas, underscoring the need to integrate water supply and hydrant networks with fire

station planning. Meanwhile, the Tabang fire emergency response application (Central Philippine University, 2022) illustrates how ICT innovations—like real-time GPS reporting—can strengthen dispatch efficiency and community involvement in emergencies.

Globally, Shahparvari et al. (2020) applied location-allocation modeling in Melbourne, Australia, increasing coverage efficiency from 81% to 95% within a five-minute response window. Chen et al. (2025) identified how rigid siting standards in China often neglect urban fire risks, calling for dynamic planning based on land-use and population density. KC et al. (2024) in Kathmandu connected fire risk to social vulnerability, finding that underserved areas with renters, LPG dependence, and low education levels required priority interventions. Similarly, Han et al. (2021) in Nanjing combined traffic data, fire incident points, and spatiotemporal modeling, improving service coverage dramatically by aligning deployment with real traffic conditions.

In the U.S., Anderson (2021) and Moore (2023) critiqued outdated volunteer-based fire systems, noting that poorly located stations fail to meet NFPA standards, highlighting the need for data-driven planning and modern infrastructure. He et al. (2024) in Shanghai likewise showed that risk-based models and hierarchical response standards can minimize both underserved rural zones and overlapping low-demand jurisdictions in urban centers.

From a design standpoint, the BFP Planning and Design Guidelines (2023) emphasize that modern fire stations should include essential facilities such as

apparatus bays, dormitories, communication centers, training areas, and dedicated storage for rescue equipment. These provisions align with the CAAP and Fire Code IRR standards on aerodrome fire safety, highlighting the importance of integrating safety and operational efficiency in land-based firefighting systems (BFP, 2023; CAAP MOS).

Altogether, these studies indicate that the proposed centralized fire station at Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte must go beyond basic siting. It should integrate GIS-based planning tools to ensure equitable coverage, adopt modern ICT hubs for dispatch and reporting, include structural facilities aligned with BFP guidelines, and provide support infrastructure like hydrants, backup water supply, apparatus bay, living quarters, support areas, and communication areas. These features will align the station with both Philippine modernization laws and global best practices, enabling efficient firefighting, rescue, and emergency response operations in the city.

CHAPTER 3

Research Methodology

This chapter outlines the research methods used to assess the feasibility and requirements for designing a centralized fire station in the City of San Jose del Monte, Bulacan. It describes the procedures employed in collecting and analyzing data from the Bureau of Fire Protection (BFP) personnel and related respondents to determine the essential facilities, spatial needs, and operational functions of a modern fire station. This chapter also discusses the research design, population and respondents, research instruments, data gathering procedures, and methods of analysis used in the study.

Research Design

This study employed a descriptive research design combining quantitative and qualitative approaches to evaluate the feasibility and requirements for designing a centralized fire station in the City of San Jose del Monte, Bulacan. The descriptive method provided factual information on existing fire stations, operational conditions, and the needs of BFP personnel and other responders. Using purposive sampling, participants with direct experience in facility management, firefighting, and rescue operations were selected to provide technical insights on key facilities, space

requirements, and operational characteristics. The qualitative component involved interviews with department heads and fire station officers, while the quantitative component used survey questionnaires for BFP staff and related personnel. Together, these methods offered a comprehensive understanding of the design and functional needs of a modern centralized fire station.

Data Gathering Procedure

Sample and Population

The population for this study consisted of personnel and individuals directly involved in firefighting, rescue, and emergency response operations within the City of San Jose del Monte, Bulacan. This included members of the Bureau of Fire Protection (BFP), firefighting volunteers, rescue and emergency responders, and on-the-job trainees (OJTs) assigned to various fire and rescue facilities in the city. These respondents were chosen because of their first-hand knowledge of fire station operations, facility needs, and structural limitations. The total sample population was 100, distributed as follows: BFP Personnel (50), Rescue and Emergency Responders (25), Firefighting Volunteers (15), and On-the-Job Trainees (OJT) (10).

The focus of the study was on personnel assigned to existing fire stations and emergency response facilities located in Barangay Sapang Palay Proper (BFP Main Office – CDRRMO Building), Poblacion 1 Fire Station – Daang Barangay, and

Tungkong Mangga Emergency Response Facility, as these are the primary operational centers of the BFP in San Jose del Monte.

Sampling Method

This study used a purposive sampling method to select respondents who have direct experience and knowledge of firefighting and emergency response operations. The participants included BFP personnel, rescue responders, firefighting volunteers, and OJTs from the known fire stations and emergency facilities in San Jose del Monte City, namely the BFP Main Office in Barangay Sapang Palay Proper, Poblacion 1 Fire Station at Daang Barangay, and the Tungkong Mangga Emergency Response Facility.

Research Instrument

The study used a researcher-made survey questionnaire to collect data from BFP personnel, rescue responders, firefighting volunteers, OJTs, and fire station heads on the design, functionality, and facility needs of a proposed centralized fire station in the City of San Jose del Monte, Bulacan.

The questionnaire had two sets. The first set for BFP staff, responders, volunteers, and OJTs included four parts: (1) current fire station conditions and challenges (yes-or-no questions on resting areas, training spaces, vehicle bays, accessibility, space allocation, and sustainability), (2) evaluation of proposed

facilities using a 5-point Likert scale, (3) perception of modernization and response efficiency using a 5-point Likert scale, and (4) open-ended recommendations.

The second set for Fire Marshals, Station Commanders, and Officers-in-Charge included five sections: station information (location, lot area, building type, establishment year), personnel and staffing (number, shifts, accommodations), vehicles and equipment (type, number, condition, parking), facility usage and space allocation (existing spaces, daily users, inadequacies), and design considerations and future needs (suggested facilities, layout improvements, structural challenges).

The questionnaire combined closed-ended and open-ended questions for quantitative and qualitative data. Content validity was confirmed by experts in civil engineering, fire safety, and research methodology.

Statistical Treatment

The study used frequency and percentage distribution for BFP staff and associated respondents to describe the demographic features of the respondents, including gender, field of engagement, and assignment location. The five-point Likert scale was used to calculate the weighted mean, which assessed their opinion of the significance and sufficiency of the planned facilities for the centralized fire station. This established the average degree of significance or agreement given to each indication. Descriptive equivalents from Strongly Agree to Strongly Disagree,

or Very Important to Not Important, were used to analyze the results, depending on the topic.

Percentage and Frequency Distribution:

$$\mathbf{P = (}\boldsymbol{n}\mathbf{ / }\boldsymbol{N}\mathbf{)(100)}$$

Where:

P = Percentage

n = Frequency

N = Total Number of Respondents

For the questionnaire distributed to Fire Marshals, Station Commanders, and Officers-in-Charge, both frequency counts and weighted means were also applied to analyze data on personnel, vehicle allocation, and facility usage. Ranking was used to determine which facilities or areas were considered most needed in a modern fire station.

Weighted Mean Formula

$$\bar{x} = \Sigma\,(f \times x) / \Sigma\, f$$

Where:

f = frequency or number of respondents

x = weight or assigned rating

$\sum(f \times x)$ = sum of the product of frequency and weight

$\sum f$ = total number of responses

Meanwhile, qualitative analysis was applied to open-ended responses to identify recurring suggestions, themes, and insights regarding the design, spatial needs, and operational improvements for the proposed centralized fire station.

Data Gathering

Site visits, interviews, and survey questionnaires were conducted to collect information on the needs and experiences of BFP personnel, rescue and emergency responders, firefighting volunteers, and related officers. Surveys also assessed current facilities and gathered suggestions for improvement. Consent was obtained from relevant offices, and all data were kept confidential and used solely for academic research.

Site Analysis

To evaluate the site's accessibility, surroundings, and suitability for the proposed centralized fire station, site visits were conducted. The site in Barangay Sapang Palay Proper lies within a government-owned property near the BFP Motorpool. The location was assessed based on space availability, accessibility, and measuring lot area. Factors such as emergency vehicle circulation, apparatus bay layout, and space utilization for fire and rescue operations were considered. The analysis ensures that the fire station will function efficiently and safely for personnel, equipment, and emergency response operations.

Design Process of Centralized Firestation

Geographical Location

The chosen site in Barangay Sapang Palay Proper lies within a government-owned property near at Motorpool, Barangay Sapang Palay Proper. The area provides ample open space with an area of 6813 meters squared, suitable for the construction of a centralized fire station and offers strategic accessibility to nearby barangays and major city zones. Its location allows for quick response to emergencies involving key government facilities, including the City of San Jose del Monte City Hall, public schools, hospitals, and residential communities.

The site's elevated terrain and wide road frontage make it ideal for the movement and parking of fire trucks and rescue vehicles. Its proximity to other government institutions supports inter-agency coordination during large-scale emergencies or disaster operations.

Design Tools and Software

The design process included the preparation of floor plans, site development plans, and 3D models using AutoCAD and SketchUp. The layout and space allocation were formulated based on the data gathered from the respondents, particularly the insights and recommendations of BFP personnel and station officers regarding operational efficiency, spatial requirements, and essential facilities. The design was developed in reference to the National Building Code of the Philippines, the Fire Code of the Philippines, BFP Modernization Act of 2021 to reflect current

standards and professional practices. Excel is used for detailed load calculations and cost estimates.

Site Development Plan

The site development plan for the proposed Centralized Fire Station in Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan, was created using AutoCAD based on survey data and consultations with BFP personnel. Strategically located near major roads and key city facilities, the site ensures quick emergency response and accessibility. It presents the general layout of buildings and open areas within the proposed fire station site. It includes the placement of the main structure, access roads, parking spaces, landscaped sections, driveways, and areas intended for vehicle movement. The plan also indicates the positioning of these facilities in relation to property limits, entrances, exits, and nearby roads to promote smooth traffic flow and easy accessibility.

Space Planning Diagram

The space planning diagram was conceptualized by the researchers using AutoCAD, guided by the data gathered from BFP personnel and station officers. The design focused on creating a layout that ensures efficiency, safety, and accessibility in daily operations. Spaces were organized according to their functions such as the vehicle bays, command and control center, and maintenance zone were placed near

the main access points for quick deployment, while administrative offices, barracks, and support areas were positioned in quieter zones to maintain comfort and order.

The researchers also considered the flow of movement for personnel and vehicles, ensuring that circulation paths were clear and that each space served its purpose without interference. Additional provisions such as training and medical rooms were integrated to support preparedness and emergency response. This layout reflects the researchers' goal of creating a practical, well-organized, and emergency-ready facility that addresses both the operational and welfare needs of BFP personnel.

Floor Plans and Structural Designs

This section presents the floor plans and structural design considerations for the proposed Centralized Fire Station. As essential components of any civil engineering project, detailed plans ensure accuracy, coordination, and clarity throughout the design process. The researchers developed detailed 2D architectural drawings using AutoCAD, illustrating the layout of key spaces. The structural plans were designed to ensure stability, structural integrity, and proper space distribution to support the operational and functional requirements of the Bureau of Fire Protection in the City of San Jose del Monte, Bulacan.

Elevations

Elevations provide a detailed visual representation of the centralized fire station's exterior from the front, sides, and rear. They illustrate the building's architectural design, proportions, and overall aesthetic, serving as a guide for construction and ensuring accurate implementation of the intended design.

Plumbing Layout Plan

This section presents the plumbing layout for the proposed Centralized Fire Station. Developed using AutoCAD, it illustrates the water supply, drainage, and sanitary systems designed to ensure efficient water flow for firefighting, daily use, and emergency needs. The layout promotes functionality, safety, and compliance with standard plumbing requirements.

Electrical Layout Plan

This section presents the electrical layout for the proposed Centralized Fire Station. Designed using AutoCAD, it shows the placement of lighting, power outlets, and main electrical lines to ensure efficient energy distribution and operational safety. The layout supports the continuous operation of essential facilities while complying with electrical standards and safety codes.

3D Design Model

The 3D design of the proposed Centralized Fire Station was created using SketchUp, reflecting the analyzed data and feedback from BFP personnel and station commanders. The model illustrates the conceptual layout of key spaces such as vehicle bays, command and control center, barracks, training, and medical areas. Each element was designed to enhance functionality, accessibility, and operational efficiency. The 3D visualization provides a clear and realistic representation of how the proposed fire station will look like as a modern facility ready for rapid emergency response.

STAAD and SAP2000

Structural analysis software is used to evaluate the strength, stability, and performance of critical structural components, including beams, slabs, columns, and foundations. The software facilitates the application of multiple load combinations, such as dead load, live load, wind load, and seismic load, in strict accordance with the provisions of the National Structural Code of the Philippines (NSCP). This analysis ensures that the proposed building design complies with safety standards, maintains structural integrity under various loading conditions, and provides a reliable basis for informed design and construction decisions.

Project Schedules

This section outlines the construction schedules for the proposed 2-storey centralized fire station. Proper scheduling was crucial to ensure coordinated work, timely completion, and optimal allocation of labor and materials. The researchers organized the project into distinct phases, arranging activities in a logical sequence to guide progress from site preparation to final turnover. Each task was assigned a specific duration and manpower requirement, enabling effective planning and monitoring throughout the construction timeline.

Bill of Quantities (BOQ)

The Bill of Quantities (BOQ) provides a systematic and detailed enumeration of all materials, labor, and associated costs required for the construction of the proposed centralized fire station. It categorizes the project into specific components, including structural, architectural, electrical, and plumbing works, with corresponding quantities and unit prices for each item. The BOQ serves as a critical tool for accurate cost estimation, resource allocation, and project feasibility assessment, ensuring that the proposed design can be executed efficiently, effectively, and in accordance with established construction standards.

Respondents: BFP Personnel / Personnel Related to Firefighting And Rescue

This questionnaire is part of a study by BS Civil Engineering students of La Concepcion College titled **"DESIGN OF A CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATIONS, RESCUE, AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE, BULACAN."** It aims to gather insights from BFP personnel and responders to identify the essential facilities and design features required for a modern, efficient centralized fire station. This survey complies with **Republic Act No. 10173**, the **Data Privacy Act of 2012**. All information gathered will be kept **confidential** and used **only for academic and research purposes.**

NAME
(Optional):_____

(Please check ✓ the appropriate box)

Gender:
☐ Male ☐ Female ☐ Prefer not to say

Field of Involvement:
☐ Bureau of Fire Protection (BFP) Personnel
☐ Firefighting Volunteer
☐ Rescue or Emergency Responder
☐ OJT (On-the-Job Trainee) in the Fire or Rescue Field
☐ Related Profession (Engineering, Safety, or Emergency Services)
☐ Others: _____

Place of Assignment or Training:
☐ BFP Main Office – CDRRMO Building, Brgy. Sapang Palay Proper
☐ Poblacion 1 Fire Station – Daang Barangay
☐ Tungkong Mangga Emergency Response Facility
☐ Muzon Emergency Response Facility
☐ Other Area: _____

Type of Emergencies Most Frequently Responded To:

☐ Structural Fires ☐ Vehicular Accidents ☐ Medical Emergencies ☐ Rescue Operations ☐ Natural Disasters ☐ Others: _____

Part I: Assessment of Current Status and Challenges of Fire Stations

Please check (✓) one box for each question.

1. Does your fire station have adequate resting and sleeping quarters for personnel on duty?
   ☐ Yes ☐ No

2. Does your fire station have a designated training or briefing area?
   ☐ Yes ☐ No

3. Is your station layout designed to support fast response and deployment?
   ☐ Yes ☐ No

4. Is your fire station easily accessible to major roads and residential areas?
   ☐ Yes ☐ No

5. Does the current space allocation (for vehicles, storage, and rest areas) meet operational needs?
   ☐ Yes ☐ No

6. Does your station have sufficient vehicle bays for all trucks and units?
   ☐ Yes ☐ No

7. Are the living quarters and day-to-day facilities (kitchen, recreation, restrooms) in good condition and adequate for on-call personnel?
   ☐ Yes ☐ No

8. Does your station include a space dedicated to community engagement or fire-prevention education (e.g., for school visits or drills)?
   ☐ Yes ☐ No

9. Has the station taken steps to incorporate sustainable design features or resilient infrastructure (e.g., backup power, energy efficiency, weather protection)?
   ☐ Yes ☐ No

10. Do you believe the station's current facility condition allows fire personnel to operate safely and comfortably at all times?
    ☐ Yes ☐ No

Part II: Evaluation of Centralized Fire Station and Needed Facilities

Matrix Rating Question

Please rate your opinion on the importance and accessibility of fire response, as well as the necessity of facilities in designing a centralized fire station for the Bureau of Fire Protection (BFP) in San Jose del Monte City.

Place a check (✓) in the box that represents your answer based on the rating scale below:

Rating Scale	Meaning
5	Very Important / Very Accessible
4	Important / Accessible
3	Moderately Important / Hard to Reach
2	Slightly Important
1	Not Important / Not Accessible

	1	2	3	4	5
Importance of establishing a centralized fire station in the city					
Accessibility of fire response in your area					
Drone operation and monitoring area					
Modern vehicle bays for fire trucks and rescue units					
Command and control center with advanced communication systems					
Communication and information technology systems					
Fire poles for quick firefighter movement between floors					
Training and simulation facilities					
Medical and rescue support rooms					
Barracks and living quarters for firefighters and rescuers					

Part III: Perception on Fire Station Modernization and Response

Please check (✓) the box that represents your answer based on the rating scale below.

Rating Scale:
5 – Strongly Agree 4 – Agree 3 – Neutral 2 – Disagree 1 – Strongly Disagree

	1	2	3	4	5
A centralized fire station can reduce emergency response time in the city.					
Properly designed vehicle bays ensure faster deployment during emergencies.					
A well-designed vehicle bay improves operational efficiency and extends the service life of fire trucks by providing proper weather protection and maintenance space.					
A command and control center enhances coordination and communication during operations.					
Medical and rescue rooms are essential for providing first aid and emergency treatment.					
Training and simulation areas strengthen firefighter preparedness and skills.					
Barracks and living quarters help maintain 24/7 readiness of fire personnel.					
Public/community engagement space (e.g., for fire-prevention education, school visits, and community drills) within the fire station enhances overall safety and community trust.					
A dedicated decontamination zone (for personnel and equipment returning from incidents) is essential for protecting fire station living and working spaces.					
Sustainable design features (e.g., solar panels, energy-efficient systems, resilient backup power) in the fire station facility are essential for ensuring uninterrupted operations during significant events.					

Part IV: Open-Ended Question

1. What other facilities or improvements would you recommend for the proposed centralized fire station in San Jose del Monte?

   _____

   _____

   _____

Respondent: Fire Marshal / Station Commander / Officer-in-Charge

This questionnaire is part of a research study by BS Civil Engineering students of La Concepcion College entitled "Design of a Centralized Fire Station for Efficient Firefighting Operations, Rescue, and Emergency Response at Motorpool, Barangay Sapang Palay Proper, City of San Jose del Monte, Bulacan." It seeks to gather technical and operational information from station officers to support the design of a centralized fire station that enhances functionality, space utilization, and emergency response efficiency. This survey complies with **Republic Act No. 10173**, the **Data Privacy Act of 2012**. All information gathered will be kept **confidential** and used **only for academic and research purposes.**

Section 1: General Information

1. **Name of Respondent:** _____
2. **Position/Designation:** _____
3. **Name of Fire Station:** _____
4. **Location/Address:** _____
5. **Lot Area (approximate):** _____ sq. m.
6. **Building Type:** ☐ One-storey ☐ Two-storey ☐ Multi-storey

Section 2: Personnel and Staffing

1. How many **total personnel** are assigned to this station? _____
2. How many **fire officers** (uniformed) are currently active? _____
3. How many **administrative/non-uniformed staff** are assigned? _____

4. How many **volunteers or OJTs** regularly assist the station? _____

5. What is the **average number of personnel per shift?** _____

6. What is the **shift system** followed?
   ☐ 24 hours on duty / 48 hours off ☐ 12-hour rotation ☐ Others: _____

7. Do personnel stay overnight on-site? ☐ Yes ☐ No

8. If yes, how many **sleeping quarters or barracks spaces** are currently provided? _____

Section 3: Vehicles and Equipment

1. How many **fire trucks** are currently operational? _____

2. What are the **types of fire trucks** available? (e.g., pumper, tanker, aerial ladder, rescue)

   _____

3. How many **rescue or support vehicles** are in service? _____

4. Where are the vehicles currently parked or stored?
   ☐ Covered garage ☐ Open area ☐ Shared space ☐ Others: _____

5. Do you encounter **space constraints** for vehicle movement or parking? ☐ Yes ☐ No
   If yes, please describe: _____

6. What is the **average number of vehicle deployments per day/week?** _____

Section 4: Facility Usage and Space Allocation

1. Approximately how many people **use the station daily** (including personnel, visitors, and trainees)? _____

2. Which areas are currently **lacking or inadequate**? (Please specify)

   _____

Section 5: Design Considerations and Future Needs

1. What facilities should a **modern centralized fire station** include to improve operations?

   _____
   _____

2. What are the **biggest challenges** in your current station's structure or facilities?

   _____
   _____

3. If given a chance to redesign the station, what **spatial improvements or layout features** would you suggest?

   _____
   _____

4. Any additional comments or recommendations for future fire station design?

   _____
   _____

CERTIFICATE OF QUESTIONNAIRE VALIDATION

This certifies that the questionnaires on our study entitled,

"DESIGN OF A CENTRALIZED FIRE STATION FOR EFFICIENT FIREFIGHTING OPERATIONS, RESCUE, AND EMERGENCY RESPONSE AT MOTORPOOL, BARANGAY SAPANG PALAY PROPER, CITY OF SAN JOSE DEL MONTE, BULACAN"

Originally owned by group E3 from BSCE-4E, Guian Abigail DP. Santos, Rheyven B. Juan, John Marwin D. Taganna, and Sophia Banico have been assessed and validated on the 27th of October 2025.

The questionnaire was carefully examined to determine whether each item appropriately measures the data required to assess facility needs, spatial distribution, and structural design considerations for the proposed centralized fire station. After extensive evaluation, the validators confirmed that the instrument is valid, appropriate, and ready for data collection.

Validated by:

10/25/25

Engr. Jore Gil D. Galeza, Ph.D., MEM, SO2
Civil Engineering Professional
(Signature over Printed Name)

Engr. Eloisa P. Cadag, CE, MACT
Civil Engineering Professional
(Signature over Printed Name)

Engr. Russell R. Llagas
Civil Engineering Professional
(Signature over Printed Name)

Certified True and Correct:

Engr. Eloisa P. Cadag, CE, MACT
Research Adviser
La Concepcion College